

The Mu3e Experiment Searching for the Lepton Flavour Violating Decay $\mu^+ \rightarrow e^+ e^- e^-$

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The Mu3e Experiment @ PSI

Motivation & Challenges

Search for Lepton Flavour Violation:

Decay : $\mu^+ \rightarrow e^+ e^+ e^-$

- Negligible in Standard Model (Br < 10⁻⁵⁴)
- Can be enhanced in New Physics : (SUSY, leptoquarks, etc.), any observed decay will point to NP
- Current status: **Br** < 10⁻¹² (SINDRUM) at 90% CL
- Mu3e Phase I: Aiming for O(10⁻¹⁵) sensitivity at existing π E5 beamline: 10⁸ μ /s
- Mu3e Phase II: Aiming for O(10⁻¹⁶) sensitivity at a new high-intensity muon beamline (HiMB): >10⁹ μ /s



Muon decay in the SM



Muon decay BSM (SUSY)

Signal:

Background:

- Three tracks: $\mu^+ \rightarrow e^+ e^+ e^-$
- Decay at rest $P_e < 53 \text{ MeV/c}$
- Common vertex
- Coincide in time $\Sigma P = 0$, $\Sigma E = m_{\mu}$

- Internal conversion background (IC BG): $\mu^+ \rightarrow e^+ e^+ e^- \nu^+ \nu^-$ (suppressed by good momentum resolution)
- Accidental background (Acc. BG): Michel $\mu^+ \rightarrow e^+ \nu^+ \nu^$ with e^+e^- , etc (suppressed by good time and vertex resolution)



-Mu3e Detector Design

Inner/outer pixel layers:

- High granularity
- Thin (to reduce MS) : 50 μ m $\approx 10^{-3}X_0$
- Efficiency > 99%
- Silicon pixel sensors (HV-MAPS)
- As close as possible to target
 - Pointing to vertex
 - Reduce effect of MS

Target:

- Hollow double cone Mylar stopping target
- vertex separation

Fibre/tile timing detector:

- Precise timing
- Suppress Acc. BG
- Charge ID



Simulation and Track/Vertex Reconstruction of the Mu3e Detector





Test-beam Data Acquisition System and Characterisation of HV-MAPS

